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F-16 Confined Space Technical Guidance Document

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The following information and instructions apply to permit-required and nonpermit-required confined spaces associated with the F-16 aircraft. The majority of activities conducted within these spaces are for inspections and routine scheduled maintenance only. Flightline, depot, and other related activities are not referenced in this document. The information presented for each space type is based on the dimensions, inner characteristics, and interviews with shop personnel. Personnel performing aircraft maintenance and support are extensively trained in safe work practices, and work is conducted in accordance with (IAW) strict Technical Order (TO) and Operating Instruction (OI) directives. The TOs and OIs govern procedures such as lockout/tagout and system checks prior to entering the various areas of an aircraft.

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F-16 FALCON

Figure 1. F-16 Falcon

INTRODUCTION

The Confined Space Technical Guidance Document is not a standardized compliance document. For specific compliance procedures, refer to AFOSH Standard 91-25, *Confined Spaces*; OSHA Standard 29 CFR 1910.146, *Permit-Required Confined Spaces*; and all other applicable AFOSH Standards, TOs, and OIs. The following information and instructions apply to permit-required and nonpermit-required confined spaces associated with the F-16 aircraft.

The majority of activities conducted within these spaces are for inspections and routine scheduled maintenance only. Flightline, depot, and other related activities are not referenced in this document. The information presented for each space type is based on the dimensions, inner characteristics, and interviews with shop personnel. Personnel performing aircraft maintenance and support are extensively trained in safe work practices, and work is conducted in accordance with (IAW) strict TO and OI directives. The TOs and OIs govern procedures such as lockout/tagout and system checks prior to entering the various areas of an aircraft. The following table, *F-16 Space Classification*, lists the classification of each space assessed on the F-16.

TABLE 1. F-16 Space Classification

F-16 Space Classification		
Space Type	**Classification**	**Page Number**
Fuel Cell #1	CP	4
Intake	CS	8
Exhaust	CS	14
NOTE: CS = Confined Space, CP = Permit-Required Confined Space, NC = Not a Confined Space.		

CLASSIFICATION CRITERIA

A space is classified as a "confined space" when it meets the criteria established by AFOSH Standard 91-25, *Confined Spaces*, and OSHA Standard 29 CFR 1910.146, *Permit-Required Confined Spaces*. ALL of the following criteria must be met in order to classified a space as a confined space:

- the space is large enough to bodily enter and perform work, and
- the space has a limited means of entry and egress, and
- the space is not designed for continuous employee occupancy.

For each confined space, only one of the following criteria must be met in order to classify a confined space as permit-required:

- contains or has the potential to contain a hazardous atmosphere, or
- contains a material that has the potential for engulfing the entrant, or
- has an internal configuration such that an entrant could be trapped or asphyxiated, or
- contains any other recognized serious safety or health hazards.

RECOMMENDED ATMOSPHERIC MONITORING

It is considered a good working practice to test the atmosphere in all confined spaces, both "permit required" and "non-permit required", prior to entry. The person designated to conduct atmospheric tests of confined spaces must be trained in operation, calibration, and maintenance of the testing equipment to include field calibration prior to each use. This may involve zero calibrating the instrument in clean air and using span gases for point calibrations. The atmospheric testing equipment must have a current calibration performed by the Test Measurement Diagnostic Equipment (TDME) lab or the manufacturer. The following atmospheric air monitoring must be conducted prior to permit-required confined space entries:

- **Oxygen (O_2):** The concentration of oxygen in the confined space must be greater than or equal to 19.5 percent and less than or equal to 23.5 percent.

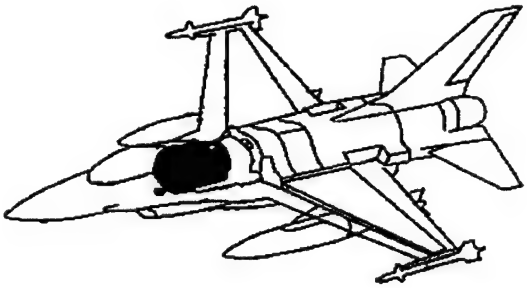
- **Flammability:** The concentration of flammable or combustible vapors, gas, or mist in the confined space must be less than or equal to 10 percent of the Lower Explosive Limit (LEL).

- **Toxic Materials:** Atmospheric concentration of any chemical substance must be below that level which may cause death, incapacitation, impairment of ability to self-rescue, injury, or acute illness due to its health effects.

During normal operations, entries must not be conducted when immediately dangerous to life and health (IDLH) conditions exist. Exceptions to this rule are found in AFOSH Standard 91-25, *Confined Spaces*, paragraph 4.3.

F-16 FALCON

FUEL CELL #1



SPACE DESCRIPTION

The F-16 contains a fuel cell between the wings of the aircraft. Fuel cells are designed with fuel bladders and foam instead of seal planes (like the integral fuel tanks) for retaining fuel. The fuel lines/components within the fuel cells are located between the inner wall of the fuel cell and the outside of the removable bladder that contains the fuel. Fuel cell #1 contains fuel lines, foam, and various fuel components.

Confined space entries into the fuel cells are performed IAW TO 1-1-3, *Inspection and Repair of Aircraft Integral Tanks and Fuel Cells, 30 November 1994.* The TO includes the following information regarding fuel cells:

- Entering fuel cells that have been depuddled, purged, docked, and grounded.
- Identifies specific repair/rework procedures, equipment, and chemicals which are authorized for use during entries into fuel cells.
- Outlines specific safety procedures such as ventilation, personal protective equipment, emergency equipment, etc.

INNER DIMENSIONS

Height = 4.0'
Length = 3.0'
Depth = 3.5' to 4.0'

ENTRY DIMENSIONS

Length = 40.0"
Width = 10.0"
(rectangular entrance)

[The depth is the distance from the entrance to the most distant point.]

SPACE ACCESS/INNER AREA

Fuel cell #1 has a single access located on top of the space, between the wings.

RECOMMENDED CLASSIFICATION

Permit-required confined space.

JUSTIFICATION FOR CLASSIFICATION

Fuel cell #1 is permit-required due to the following conditions:

- contains or has the potential to contain a hazardous atmosphere, and
- has an internal configuration such that an entrant could be trapped or asphyxiated.

TASKS PERFORMED WITHIN THE SPACE

Personnel from several work centers can enter fuel cell #1 to perform both general and emergency maintenance activities. These work centers may include Aircraft Structural Repair, Non-Destructive Inspection Maintenance, ISO Dock, etc. The majority of activities conducted within this space are for inspections and routine scheduled maintenance only, and no chemicals are used. Flightline, depot, and other related activities are not referenced in this document. However, some tasks performed during aircraft structural repair and ISO Dock maintenance, may require the use of various solvents, cleaners, adhesives, paints, and primers. The following lists scheduled routine maintenance conducted predominantly by the Fuel Systems shop:

- The fuel cell is replaced IAW TO 28JG-10-1. No chemicals are used during this procedure.
- The boost pump is replaced IAW TO 28JG-20-2. No chemicals are used during this procedure.
- The fuel cavity is repaired IAW TOs 1-1-3 and 1F-16C-3-1. A four-parts cleaner is used during this task.
- Removal and reinstallation of plumbing for various fuel systems and other related components.

Only authorized materials, or materials which have been fully evaluated and approved by Installation Ground Safety (SEG), Installation Fire Department (CEF), and Bioenvironmental Engineering (BE) offices can be used within the fuel cell. Hot work, such as grinding, welding or brazing in a permit-required confined space requires a confined space entry permit AND a hot work permit. Both permits must be reviewed and approved in writing by SEG, CEF, and BE prior to conducting any hot work in the space.

POTENTIAL HAZARDS

The following table, *Potential Hazards*, contains various hazards that could be encountered when performing permit-required confined space entries into fuel cell #1. The systems described in the table are closed/contained, and are hazardous if they are intentionally opened or a significant leak occurs. These conditions are unlikely due to personnel training and specific aircraft TOs and OIs that are strictly complied with. The TOs and OIs govern procedures such as lockout/tagout and system checks prior to entering the various areas of the aircraft.

TABLE 2. Potential Hazards (Fuel Cell)

POTENTIAL HAZARDS	
Hazard	**Hazard Description**
Combustibility	Fuel cell #1 has the potential to contain jet fuel and/or jet fuel vapors that are combustible.
Entrapment	Fuel cell #1 is an extremely confined area that contains several structural braces and fuel components throughout the space. This creates an entrapment hazard for entry personnel due to limited maneuverability and delayed egress.
Hazardous Materials Present	Jet fuel and/or fuel vapors may be present. Jet fuel and its constituents (e.g., benzene, toluene, xylene) can be a potential hazard to the entrant by route of inhalation, skin absorption, ingestion, and contact.
Introduction of Hazardous Materials	The solvents and cleaners that are used for cleaning, and adhesives that are used to seal the tanks, could potentially include hazardous materials. Only authorized chemicals should be used within the fuel cells.
Oxygen Deficiency	Due to unfavorable ventilation and the possible presence of jet fuel vapors which can displace the oxygen in these areas, oxygen deficiency is a potential hazard. In addition, several operations are performed within the fuel cavities that require the use of solvents, cleaners, and/or adhesives. Depending on the quantity and duration of use, the constituents of the chemicals could displace the oxygen within the space.
Temperature Extremes	Temperature extremes may present a hazard due to one or a combination of several factors such as ambient temperature, radiant heat, local winds, support equipment, and PPE.
Unfavorable Natural Ventilation	Due to the small entry access and confined area, there is normally minimal natural ventilation within these spaces.

RECOMMENDED ENGINEERING/ADMINISTRATIVE CONTROLS

The following engineering and administrative controls should be in place prior to making permit-required confined space entries into fuel cell #1:

- **Depuddling:** Fuel cells will be defueled, drained, depuddled, and purged to the extent necessary to perform the required tasks.

- **Electrical:** Except for specific depot exclusions, the aircraft electrical system shall be deenergized and locked and tagged out prior to opening fuel cells. The aircraft should also be grounded and bonded prior to entry.

- **Lockout/Tagout:** Lockout/tagout procedures must be performed on electrical and mechanical systems prior to entry. Danger tags are placed on the relevant circuit breakers, batteries, and external power. Restricted areas are established to minimize foot traffic.

- **Ventilation:** Fuel cells shall be ventilated for 30 minutes prior to space occupancy and continuously during entry. Ventilation must be used as necessary to ensure safe atmospheric conditions during entry.

- **Administrative:** Personnel should minimize the time spent in confined spaces by performing only necessary tasks within the space. Any work that can be conducted outside of the space should not be performed during the entry.

RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT (PPE)

PPE must be assigned based on the atmospheric conditions of the confined space, the physical hazards present, the task being performed, and the hazardous materials being used. Protective equipment that may be used for tasks in this space include:

- respiratory protection,
- non-absorbent coveralls,
- approved footwear,
- nitrile or neoprene gloves for sealant operations,
- cap or head covering,
- goggles or safety glasses with side shields, and
- neoprene rubber knee pads, elbow pads, or mats.

RECOMMENDED EMERGENCY EQUIPMENT

The following emergency equipment is recommended to be present in the Fuels or Flightline Maintenance area and verified to be in working condition by the designated entry authority prior to authorizing confined space entries:

- intrinsically safe hand radio,
- 150 pound halon fire extinguisher,
- intrinsically safe flashlights, lamps, or lanterns rated for class I, division 1 hazardous atmospheres,
- additional respiratory protection as recommended by BE, and
- rescue webbing harness.

F-16 FALCON

INTAKE

SPACE DESCRIPTION

The F-16 contains an intake along the underbelly of the aircraft, between the wings. The intake contains fan blades/motor, an anti-ice probe, sensors, electrical lines, and structural components.

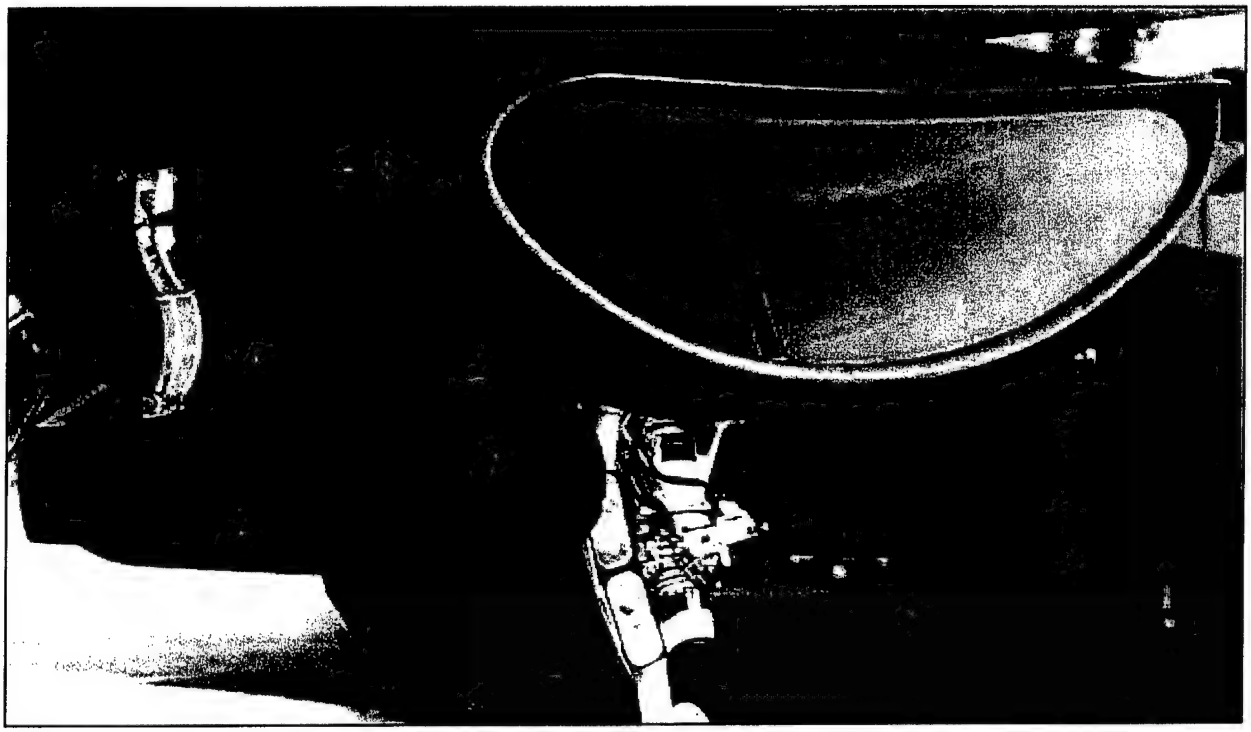


Figure 2. Intake: Forward access of intake. A support strut is located in front of the forward access.

INNER DIMENSIONS

Height = 1.5' to 5.0'
Width = 3.5' to 5.0'
Depth = 15.0'

ENTRY DIMENSIONS

1. Forward: Length = 3.5' Width = 0.5' to 1.5'
2. Aft: Diameter = 5.0'
(irregular shaped entrance)

[The depth is the distance from the entrance to the most distant point.]

SPACE ACCESS/INNER AREA

The intake is semi-cylinder shaped with an access at each end. The inner area tapers from aft to forward. The intake cannot be entered from the aft access unless the engine is removed.

RECOMMENDED CLASSIFICATION

Non-permit required confined space.

JUSTIFICATION FOR CLASSIFICATION

The intake contains a variety of closed/contained systems that are not CREDIBLE potential hazards, and therefore it is not a permit-required confined space. The systems are hazardous if they are intentionally opened or a significant leak occurs. These conditions are unlikely due to personnel training and specific aircraft TOs and OIs that personnel are strictly required to comply with. The TOs and OIs govern procedures such as lockout/tagout and system checks prior to entering the various areas of the aircraft.

TASKS PERFORMED WITHIN THE SPACE

Personnel from several work centers can enter the intake to perform both general and emergency maintenance activities. These work centers may include Aircraft Structural Repair, Non-Destructive Inspection Maintenance, ISO Dock, etc. The majority of activities conducted within this space are for inspections and routine scheduled maintenance only, and no chemicals are used. Flightline, depot, and other related activities are not referenced in this document. However, some tasks performed during aircraft structural repair and ISO Dock maintenance, may require the use of various solvents, cleaners, adhesives, paints, and primers. The following lists scheduled routine within the intake:

- The Flightline personnel perform pre-flight, post-flight, and thru-flight general inspections within the intake. Each inspection takes approximately 15 minutes. Each inspection involves examining the surface of the intake, the fan blades, struts, inlet guide vanes (IGVs), the T25 sensor, the installation of the center body, and a check for dents and scratches. The Structural shop and Engine Test Cell shop perform repairs resulting from these visual inspections. Structural damage is assessed by the Non-Destructive Inspection (NDI) work center.

- Flightline personnel also check the vertical play of the ice detector when the system calibration is beyond the acceptable limits, or when the sensor has been replaced. This process takes five minutes and is conducted approximately once a year per aircraft. Dry ice is applied to the probe as a quality assurance check to determine if it is operating properly.

- The Structural shop personnel perform repairs to the front frame of the engine 1 to 12 times per year. These repairs can take 15 minutes to 1.5 hours. The repairs involve stop-drilling cracks on the engine struts, polishing the drilled holes with an abrasive wheel, then sealing the holes with RTV sealant. These tasks are conducted IAW TO 1F-16C-2-70FI-00-11.

- Structural work center personnel perform paint touch-ups using a brush or sempen one to six times per year for each aircraft. Each operation takes 15 minutes to 1 hour. Approximately 0.5 ounces of isopropyl alcohol is used to clean the area that will be painted. The cleaned surface is then painted with approximately 0.5 ounces each of an epoxy polyamide primer, followed by a white polyurethane top coat. The paint system must cure for 72 hours before the engines can be started. These operations are conducted IAW USAF TO 1F-16C-23, *Corrosion Control (Paint Touch-up)*.

- The Structural work center is also responsible for repairing the rubber-like coating in the F-16 intake. The coating can be damaged by rivets that have come loose, fuel cell leaks, etc. Repair of the coating involves removing the damaged coating with a plastic scraper. Approximately 3 ounces of isopropyl alcohol is used to remove any residue left behind. The metal surface is treated with Alodine 1200 (approximately 0.5 grams) to prevent corrosion, followed by the application of approximately 0.5 ounces of a flexible primer, and 1 to 6 ounces of a filled thixotropic spreadable repair compound. Once cured, an epoxy polyamide primer is applied with a brush or sempen, followed by a polyurethane top coat (approximately 0.5 ounces each). This procedure is conducted IAW USAF TO 1F-16C-3-1 (51-09-00).

- The NDI work center performs fan blade inspections caused by bird strikes and other debris damage. During this inspection, the damage is assessed using a current tester which applies an electromagnetic current to detect cracks in metal. These tests are performed approximately six times per year. Each inspection takes approximately 1 hour and 15 minutes to perform. All NDI inspections are performed IAW USAF Technical Manual 2J-F110-9, *Nondestructive Inspection*.

- The NDI work center performs fluorescent penetrant inspections (FPIs) to assess cracks found during F-16 pre-flight, post-flight, and thru-flight general inspections. The suspect area is wiped with a rag containing a cleaner (MAGNAFLUX, SPOTCHECK® Cleaner/Remover SKC-S). This is followed by the application of a green dye (MAGNAFLUX, ZYGLO® Penetrant, ZL-27A) using a Q-tip. For faint cracks, a thin layer of developer (MAGNAFLUX, ZYGLO® Developer, ZP-9F) is sprayed over the green dye. The dye is allowed to sit for 30 minutes during which time there is no entry into the intake. After 30 minutes, a black light is shined on the dye and any cracks identified are marked with a Skill Craft indelible marker. This operation is performed approximately once per month and takes 1 hour per inspection. All NDI inspections are performed IAW USAF Technical Manual 2J-F110-9, *Nondestructive Inspection*.

- The NDI work center also performs phase inspections on operational aircraft after every 200 hours of operation. Phase inspections involve using a current tester and an ultrasonic tester, which utilizes high frequency sound waves to detect cracks. These inspections are done for the entire fleet approximately six times per year. Each test takes approximately 1 hour to perform. All NDI inspections are performed IAW USAF Technical Manual 2J-F110-9, *Nondestructive Inspection*.

Only authorized materials, or materials which have been fully evaluated and approved by SEG, CEF, and BE offices can be used within the integral fuel tanks and the intake. Hot work, such as grinding, welding or brazing in a permit-required confined space requires a confined space entry permit AND a hot work permit. Both permits must be reviewed and approved in writing by SEG, CEF, and BE prior to conducting any hot work in the space.

F-16 FALCON

EXHAUST

SPACE DESCRIPTION

The F-16 contains an exhaust at the rear of the aircraft. The exhaust contains blades, sensors, and structural components.

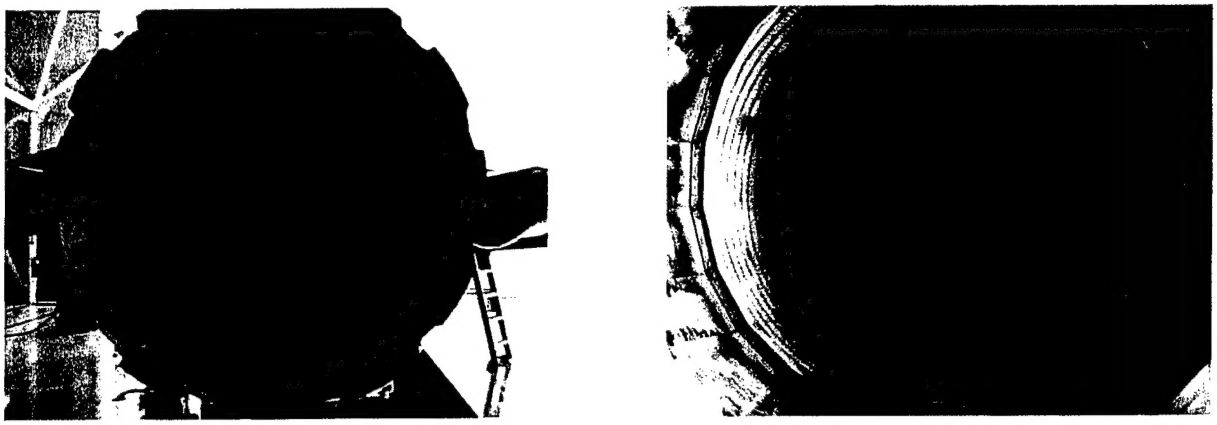


Figure 3. Exhaust

SPACE ACCESS/INNER AREA

The engine exhaust is circular with one large access. There are structures which require inspection towards the body of the aircraft.

RECOMMENDED CLASSIFICATION

Non-permit required confined space.

JUSTIFICATION FOR CLASSIFICATION

The engine exhaust contains a variety of closed/contained systems that are not CREDIBLE potential hazards, and therefore it is not a permit-required confined space. The systems are hazardous if they are intentionally opened or a significant leak occurs. These conditions are unlikely due to personnel training and specific aircraft TOs and OIs that personnel are strictly required to comply with. The TOs and OIs govern procedures such as lockout/tagout and system checks prior to entering the various areas of the aircraft.

TASKS PERFORMED WITHIN THE SPACE

Personnel from several work centers can enter the engine exhaust to perform both general and emergency maintenance activities. These work centers may include Aircraft Structural Repair, Non-Destructive Inspection Maintenance, ISO Dock, etc. The majority of activities conducted within this space are for inspections and routine scheduled maintenance only, and no chemicals are used. Flightline, depot, and other related activities are not referenced in this document. However, some tasks performed during aircraft structural repair and ISO Dock maintenance, may require the use of various solvents, cleaners, adhesives, paints, and primers. The following lists scheduled routine maintenance within the engine exhaust:

- The Flightline personnel perform pre-flight, post-flight, and thru-flight general inspections within the exhaust. Each inspection takes approximately 15 minutes. Each inspection involves examining the surface of the exhaust and the blades for dents and scratches. The Structural shop and Engine Test Cell shop perform repairs resulting from these visual inspections. Structural damage is assessed by the Non-Destructive Inspection (NDI) work center.

- The Structural shop personnel perform repairs to the front frame of the engine 1 to 12 times per year. These repairs can take 15 minutes to 1.5 hours. The repairs involve stop-drilling cracks on the engine struts, polishing the drilled holes with an abrasive wheel, then sealing the holes with RTV sealant. These tasks are conducted IAW TO 1F-16C-2-70FI-00-11.

- Structural work center personnel perform paint touch-ups using a brush or sempen one to six times per year for each aircraft. Each operation takes 15 minutes to 1 hour. Approximately 0.5 ounces of isopropyl alcohol is used to clean the area that will be painted. The cleaned surface is then painted with approximately 0.5 ounces each of an epoxy polyamide primer, followed by a white polyurethane top coat. The paint system must cure for 72 hours before the engines can be started. These operations are conducted IAW USAF TO 1F-16C-23, *Corrosion Control (Paint Touch-up)*.

- NDI performs Exhaust inspections caused by bird strikes and other debris damage. During this inspection, the damage is assessed using a current tester which applies an electromagnetic current to detect cracks in metal. These tests are performed approximately six times per year. Each inspection takes approximately 1 hour and 15 minutes to perform. All NDI inspections are performed IAW USAF Technical Manual 2J-F110-9, *Nondestructive Inspection*.

- NDI performs fluorescent penetrant inspections (FPIs) to assess cracks found during F-16 pre-flight, post-flight, and thru-flight general inspections. The suspect area is wiped with a rag containing a cleaner (MAGNAFLUX, SPOTCHECK® Cleaner/Remover SKC-S). This is followed by the application of

a green dye (MAGNAFLUX, ZYGLO® Penetrant, ZL-27A) using a Q-tip. For faint cracks, a thin layer of developer (MAGNAFLUX, ZYGLO® Developer, ZP-9F) is sprayed over the green dye. The dye is allowed to sit for 30 minutes during which time there is no entry into the exhaust. After 30 minutes, a black light is shined on the dye and any cracks identified are marked with a Skill Craft indelible marker. This operation is performed approximately once per month and takes 1 hour per inspection. All NDI inspections are performed IAW USAF Technical Manual 2J-F110-9, *Nondestructive Inspection*.

- NDI also performs phase inspections on operational aircraft after every 200 hours of operation. Phase inspections involve using a current tester and an ultrasonic tester, which utilizes high frequency sound waves to detect cracks. These inspections are done for the entire fleet approximately six times per year. Each test takes approximately 1 hour to perform. All NDI inspections are performed IAW USAF Technical Manual 2J-F110-9, *Nondestructive Inspection*.

Only authorized materials, or materials which have been fully evaluated and approved by SEG, CEF, and BE offices can be used within the integral fuel tanks, intake, and exhaust. Hot work, such as grinding, welding or brazing in a permit-required confined space requires a confined space entry permit AND a hot work permit. Both permits must be reviewed and approved in writing by SEG, CEF, and BE prior to conducting any hot work in the space.